

ASSEMBLY AND PACKAGING OF FLAT-CABLE HARNESSSES

The invention relates to the packing of a cable harness, also called a cable tree, but in the following generally designated simply as a cable harness, which is completed and/or which rests on a carrier, preferably consisting of or containing flat cables, and its assembly out of the packaging.

In recent years in the prior art, cable harnesses have consisted exclusively of round cables (for which, the individual conductors, with or without twisting, are arranged such that the cable generally has an essentially circular cross section), which were manufactured basically completely by hand from individual cable sections. All attempts to connect round cables automatically into cable trees and to attach the necessary connectors, etc. have failed at the latest during the attempt to transfer the manufacturing from the laboratory to production. The increasing use of flat conductor cables, also called simply flat cables or even shorter FFC, has allowed the gradual realization of automated cable-tree production.

According to the current state of the art, finished cable harnesses are still packed manually for shipping or for transport. After functional tests, the cable harnesses are placed by hand into various types of packages, usually in small-load carriers (KLT) or plastic bags. As preparation for the packing, the cable harnesses are folded manually by bending the outgoing leads parallel to the main branch in order later to be wrapped together with the branch. The cable harnesses, which are usually several meters long, thus form a group, which in most factories must be manipulated by two or more persons. Such a method is described in US 5,829,110 A, wherein the folding of branches and also the connection of folded branches is already done by machine, but nothing is mentioned about further packing or transport.

This method features inevitable human errors already during the packing as risk factors to the quality of the end product. For further processing, e.g., the assembly in a vehicle or vehicle component, such as the door, roof, or the like, the cable harnesses are taken out of the packing again, rolled out starting from a marked, correspondingly specified point of the cable harness on the floor or a matching work surface and returned to approximately the original shape. Then the cable harnesses are brought into the vehicle or onto a vehicle part and there inserted by hand into channels for the cables, suitably fixed, and connected by their connectors to the devices or loads.

A subordinate class of cable harnesses, which consist of round cables, has durable, tubular enclosures, which protect the sheathed cable against mechanical damage also during transport to final assembly. From US 6,120,327 A it is known to produce the enclosures from material with "shape memory," so that the cable harness again assumes the original, three-dimensional shape, which corresponds to the final, desired shape, after deformation during transport. For many applications of round cables and for FFCs in general, these enclosures

5 cannot be used or are even disruptive. In addition, these enclosures are not transport packaging and do not make such packaging unnecessary.

The goals of the invention are to simplify the processes mentioned in the introduction and primarily to provide an automated production in order, on the one hand, not to adversely affect the quality of the finished cable harness during its packaging, its transport, and its unpacking, and, on the other hand, to reduce the costs for these processes. Thus, the invention relates to
10 several aspects in the chain from packaging of finished cable harnesses to their assembly in the vehicle.

These goals are achieved according to the invention by the following measures:

When packing the cable harness, a cable harness completed on its carrier is gripped and
15 held by a packaging device at predetermined points, e.g., at the connectors; the carrier is removed at least in regions lying between these holding points; the holding points are brought closer to each other parallel to a common direction; the cable harness is set into a packaging enclosure; a template-like holder with fixing points for the holding points is brought into the packaging; and the holding points are fixed to the fixing points of the template-like holder.

20 When unpacking the cable harness, a handling device grips the cable harness at its holding points and removes it from the fixing points; the holding points are brought into the position it had assumed on the carrier; and the cable harness is then brought to the installation station or to an intermediate storage location.

The invention also relates to packaging for a cable harness, which consists of at least one
25 packaging enclosure and a template-like holder, which has fixing points for holding points of a cable harness.

The invention is explained in more detail in the following with reference to the drawings. Shown are

30 Figure 1, the gripping of a cable harness, which rests on its carrier, according to the invention,

Figure 2, the gripped and pushed-together cable harness, and

Figure 3, the cable harness placed in its packaging in the folded state.

Figure 1 shows purely schematically a cable harness 1 lying on a carrier 2, on which the cable harness was produced. Above the carrier 2, a packaging device 3 according to the
35 invention is shown, which can either be part of the production device for the cable harness 1 or a separate device, which then either travels over the finished cable harness or which receives the finished cable harness on its carrier, on which it can be transported, of course, without a problem.

In the illustrated embodiment, the packaging device has four holding elements 4, 5, 6, 7, which are positioned appropriately over the cable harness 1. These holding elements 4, 5, 6, 7
40 feature gripping or holding devices (e.g., operated by vacuum, mechanical clamps, or suction

5 cups), which can interact with the components of the cable harness and which grip and hold these components. In most cases, connectors, which are attached to the cable harness and are held directly on the carrier, whose positions are thus defined precisely, are selected as holding points. Then the gripping devices of the packaging device can be matching connectors, which can move or which have moving parts, such that they can grip and release the connectors.

10 In the illustrated embodiment, the holding element 5 is fixed tightly to the packaging device 3, the holding element 4 can move in the direction of arrow F, and the holding elements 6 and 7 can move in common in the direction of arrow -F, wherein after successfully laying down the cable harness, the individual holding elements can, of course, be moved back into the shown starting positions (or also beyond these positions).

15 After the cable harness 1 has been gripped and held by the gripping devices of the holding elements 4, 5, 6, 7, it is separated from the carrier 2, such that the holding members provided, if necessary, on the carrier, are released, and in a corresponding way, which is dependent on the structural type of the carrier and on the size of the cable harness and the number of holding points, the holding elements move as described above, which significantly
20 reduces the size of the cable harness in the direction of movement by forming suspended loops 10.

Then a template-like holder 8, which can be formed in one piece or also in several pieces, is brought from below into the region of the cable harness 1, so that the loops 10 slide through openings 11 of the holder. This template-like holder 8 is preferably also held and positioned by
25 the packaging device 3 or by a device interacting with the packaging device. During the use of a multiple-part holder 8, it is also possible to position these parts under the cable harness before the movement of the holding elements 4, 5, 6, 7, as well as to move the individual parts accordingly with the holding elements. This does require greater logistical expense, but avoids all problems with the passage of the loops 10 through the openings 11 of the holder 8.

30 Then the template-like holder 8 is brought over a packaging enclosure 9, a type of external packaging, or vice versa, and lowered or placed on holding points in the packaging enclosure 9.

This situation is shown in Figure 3. As can be seen from the orientation of the loops 10 formed by the cable harness 1 while pushing the holding devices 4, 5, 6, 7 together, in the
35 illustrated embodiment, the template-like holder 8 was moved from left to right relative to the packaging enclosure 9 during the lowering, wherein the loops are laid in order. This relative motion can obviously also be achieved for a horizontally immovable holder 8 by a corresponding movement of the packaging enclosure 9.

5 In the course of the steps, which are shown in Figures 2 and 3, the holding points of the cable harness 1 are also connected to the corresponding fixing points of the template-like holder 8, so that these holding points assume a precisely defined position and also remain in order.

For the removal of the cable harness 1 from the packaging, it is necessary only to bring a handling device, which is built equivalently or similarly to the packaging device 3 and which can
10 be a part of an assembly device for the cable harness, with its holding and gripping elements into the known position, which the holding points of the cable harness 1 assume in the packaging and especially on the template-like holder 8, to grip them there, to lift them from the holder, and through corresponding separation of the individual gripping and holding elements to bring the cable harness back into the position shown in Figure 1.

15 In the course of the description, when "location" or "position" of the holding points is mentioned, they are understood to mean not only positioning on the template-like holder or the carrier, but also orientation relative to the normal line to the plane defined by the carrier or the template-like holder in this region and obviously also the angular position relative to this plane. Thus, it can be a location defined in all six degrees of freedom, which makes gripping and
20 manipulation possible for the first time. This location can be predetermined and maintained, because the production of the cable harness on the carrier 2 precisely fulfills these requirements, so that, on the one hand, it is necessary, and on the other hand, it is sufficient, if this position also remains known during the packaging, transport, and unpacking for the essential points of the cable harness, which is guaranteed by the method according to the invention and the packaging
25 according to the invention.

For the most part, one chooses all or a few of the connectors, which carry the cable harness, as the holding points, because the connectors are the critical and essential points of the cable harness and because the gripping and positioning of the connectors in the course of the assembly of the cable harness in the vehicle or device is necessary, and thus its position must be
30 known for all cases. Obviously, it is also possible to select other positions of the cable harness as holding points and even to provide a few holding aids under some circumstances. These can be optical and/or magnetic and/or geometrical parts, which are adhered or welded to the appropriate positions of the cable tree.

In the illustrated embodiment, the cable harness 1 originally produced on its carrier 2 is
35 markedly shortened by forming two loops 10 in its longitudinal direction, and, obviously, the formation of several loops is possible. For complex cable trees, it is also possible to bring the holding points closer together in a direction that deviates from the first direction F, -F and especially, but not necessarily, lies normal to this direction, in order to reduce a second dimension of the cable tree.

5 The template-like holder 8 brought under the cable harness 1 gripped by the packaging device 3 can be formed in one piece, wherein its edge regions (not shown in Figures 2 and 3) are formed continuously in order to guarantee integrity, while the loops 10 then hang through sufficiently wide slots 11 of the holder 8. However, it is also possible to form the holder 8 in several parts and to provide matching contacts and fixings, which guarantee the predetermined position of the individual parts of the holder 8 and thus the predetermined position of the holding points of the cable harness 1, for each of the parts in the packaging enclosure. It is also possible to fix the individual parts of such a holder to each other or in the "shortened" position by means of a connecting part and to bring all of the parts as one unit into the packaging enclosure.

15 As can be inferred from the discussion, the problems of calibration and the addition of tolerances are essentially more favorable in the case of a single-piece holder than in the case of a multiple-piece holder (which in turn has no problems with the passage of loops) and is thus preferred, but there are special cases, especially for complex cable trees, for which the multiple expense of calibration and inspection increases due to the possibility of transporting and assembling a more complex cable harness in one piece.

20 The material for the packaging, thus for the packaging enclosure and also the template-like holder, can be corrugated cardboard, which has the advantage of being able to be delivered flat to the packaging location, which can be stamped and folded with sufficient precision, and which can be recycled easily and without problems after the removal of the cable harness at the assembly location. Obviously, it is also possible to replace a packaging enclosure made from corrugated cardboard with a holder made from plastic, which can then be preferably reused, but here there is always the problem of transporting the already used device back to the packaging location. As actual holders, both in the case of a holder made from corrugated cardboard and also a holder made from plastic, there are form-fitting cut-outs for the outlines of the holding points, especially when it concerns connectors. For the use of multiple-use plastic holders, the provision of more complicated fixing devices, e.g., magnetic-type devices combined with geometrical features, is also possible.

35 Obviously, the used corrugated cardboard can be coated or provided with special inserts for fixing the holding points. It is also possible to use other material with the knowledge of the invention and the corresponding requirements on the packaging. It is a simple problem for someone skilled in the art of packaging technology to select the corresponding materials.

 Finally, it is also conceivable to use the holder, which then preferably has multiple parts, as a carrier, wherein the intermediate pieces, which are required for production but which are unnecessary for transport, can be realized by simple rails or table-like formations, so that these represent a kind of "rest carrier."

- 5 The description mostly discusses only one type, which completes individual movements of a part relative to another part, but it is obviously always possible to select another type of movement. It is essential only to reach the indicated end positions in the course of a relative movement.